

# MULTI-POINT SEAT BELT

## CROSS REFERENCE TO RELATED APPLICATIONS

This is a continuation-in-part application of an international application number

- 5 PCT/DE98/03270 (WO 99/24294, European Patent EP 1 037 773 B1, German Patent DE 197 49 780 C2) filed Nov. 10, 1998.

## BACKGROUND OF THE INVENTION

### 1. Field of the Invention:

- 10 It is an object of the present invention to ensure the restraint of a passenger in order to enhance the survival chance associated with lowering all acceleration-dependant forces
- in the event of any accident (front-, side-, rear-end collision and/or rollover or pile up/mass collision) of a transport system (a motor vehicle, a train or an aeroplane) or
  - during turbulence-related vibrations of an aeroplane.

### 15 2. Discussion of the Prior Art:

It is known in the prior art to provide for a passenger of a transport system

- a three-point seat belt (safety belt or lap-shoulder seat belt assembly), mounted in the motor vehicle, consisting of a shoulder belt extending across the upper part of his body and of a lap belt extending across the lower part of his body; or
- 20 – a two-point seat belt, mounted in the aeroplane, acting as lap belt extending across the lower part of his body; or
- a suspender- (waist-) belt consisting of several pieces (belt-members).

It is well known to provide different restraint systems in vehicles, predominantly, three-point  
25 seat belts in various types for seats, exemplified by DE 37 41 831 A1 shown in Fig. 11.

Evidently, when both shoulders of a passenger, conventionally belted, are not restrained in the event of an arbitrary collision with another vehicle in any direction, shown in Figs. 3, 4 and 7, the unrestrained shoulder can always move and/or rotate freely, thereby resulting in severe/fatal injuries in real-world accidents when

- 30 – the head crashes into the steering wheel and/or window pane and/or
- the airbag crushes the head, which, loaded by the forces related to pitch-acceleration  $\ddot{U}_H$ , yaw-acceleration  $\ddot{O}$ , longitudinal and/or lateral acceleration, is in "oop" (out of position).

Moreover, by the definition of „submarining” the belted passenger submarines (slips downward) under his seat belt thus negating the protective effect of the seat belt.

It is well known to provide two-point or lap seat belts for aeroplane seats as well as mid-portion of the rear seats of motor vehicles. This lap seat belt is far less effective than a three-point seat belt. Due to very large accelerations during a turbulence-related flight the protective effect is very low.

A substantially improved protection is proposed by two different configurations of a one-piece seat belt, exemplified by DE 26 02 875 A1 (Figs. 8 to 10). An „X-shaped” restraint is arranged by extending both shoulder belts crosswise over the upper part of body while the lower part of body is restrained by the lap belt. Each end of the one-piece seat belt is connected to a belt retractor, fastened in the seat backrest. Two grab rings, positioned to the headrest, move along the belt. A single or double „X-shaped” configuration is defined by pulling a pair of grab rings and belt portions over the head, shoulders and head rest and engaging them in the corresponding hooks. Due to such intricate operation the seat belt remains unused.

According to US 3,977,696, US 5,123,673, US 5,411,319, DE-OS 23 45 847, DE-OS 28 13 888 and DE 196 29 878 A1 the restraint system comprises a three-point seat belt, a second shoulder belt and two belt retractors, responsible for retracting both belts. The „X-shaped” configuration, formed by extending both belts crosswise over the upper part of the body, has the following drawbacks in the event of an accident:

**D1.** Both belts are retracted to different length by two independently operating belt retractors within milliseconds.

**D2.** Under the load of the same belt force in a front collision the deformation of seat backrest, wherein both belt ends are fastened, is larger, thus increasing the forward motion.

Furthermore, it is impossible to attach an energy absorber because all four belt ends are occupied.

A one-piece seat belt 1 (Fig. 1) ref. to DE-OS 28 13 888 is equipped with two belt retractors (not drawn), fastened to both belt ends in the seat backrest, and a belt deflector 17, anchored to the seat frame 3.3 of the mid-portion of rear seat. The feature, proposed for a child, has the following drawbacks:

**D3.** When the release button 84 is depressed, the belt portion 1.1 gets entangled around the neck of passenger. For the operation of restraining and extending both belt portions into the „X-shaped” configuration, the passenger must lower his head first.

**D4.** Because all belt ends are occupied, it is impossible to attach energy absorbers and to  
5 adjust the belt to the size of an upper part of body 95 of an adult.

Generally, a child-seat is fastened by four auxiliary belts to the seat. Despite the „X-shaped” configuration of a one-piece seat belt to restrain a child, sitting in a child-seat, ref. to FR 2 342 872 A1 the problems, associated with the retraction of four auxiliary belts, submarining and energy absorption, remain unsolved in an accident.

10 Till now, trains, school buses and buses are not provided with restraint systems.

### SUMMARY OF THE INVENTION

Accordingly, the principle object of the present invention is to provide for passengers of a transport system seat belts, each, equipped with a belt retractor, solely responsible for  
15 retraction, blocking and tightening or for protraction, a lower belt deflector to loosely guide a belt portion and multi-attachment points (multi-points of restraint), restrains a passenger in multi-attachment points, in order to lower and distribute the acceleration-dependent loads, shown in Fig. 3 and Tables 1 to 3, to the multi-attachment points in the event of any accident thereof or turbulence-related vibrations of an aeroplane. Nowadays, belt tighteners are  
20 incorporated into belt retractors, for example, of MB 500 SL in order to save costs, assembling time and space.

A second object of the present invention resides in a user-friendly belt-feeding device to ease the restraint and in a master release button, when depressed, to release all latch plates from the buckle assemblies and/or return the belt-feeding device to the home position.

25 A third object of the present invention resides in a cost-, space-saving integration of the multi-point seat belt, equipped with energy absorbers, and the seat into a baby-cot, child-seat or safety seat, illustrated in Figs. 1, 23.

### 30 INDUSTRIAL APPLICABILITY

It should be apparent that the invention provides a substantially improved restraint including the following features:

a) The survival chance is enhanced by the restraint of

- \* both shoulders and the torso, when the passenger is thrown forward (**Fig. 4, Table 3**) and/or subjected to the yaw  $\ddot{\alpha}$ -acceleration-dependent torque  $T_{\alpha}$ , and
- \* both thighs and the lower part of the body, when the passenger submerges.

5 b) Because the belt retractor is attached to one belt end, a number of sets of energy absorbers ref. to WO 99/24292 (PCT/DE98/03271, European Patent EP 1 037 771 B1, German Patent DE 197 58 498 C2, pending US and CA patent) or German Patent DE 197 58 497 C2 can be attached to the other belt end (**Figs. 12a, 12b, 18**), thus gradually absorbing large impact energy below the respective injury-related values. The inventor of the present  
10 application has submitted those patent documents and applications to CIPO as well as USPTO. The energy absorber consists of a number of clamping elements, having sites of predetermined fracture, and a retaining element, which, fastened to the seat backrest frame and/or seat frame, can serve as an integral part thereof.

15 c) Owing to the different positions of buckle assemblies, in plug-in connection with the respective latch plates, passengers of different body proportions can adjust the belts by themselves. Moreover, the seats, equipped therewith, for adults can be modified for children and vice versa, thus augmenting the rate of seat occupancy in a bus, train or an aeroplane, exemplified in **Fig. 23**.

20 d) In another embodiment an upper belt deflector **5b** (**Fig. 15**), in plug-in connection with the buckle assembly **4**, or the buckle assembly **4** is height-adjustable. Energy absorbers, above-mentioned, can be connected to this buckle assembly. Upon the use of the height-adjustable belt deflector **5b** the height-adjustable D-ring **12**, attached to the B-, C-, D-post section (pillar, pillar portion), shown in **Fig. 1**, or to the top edge of the seat backrest, is no longer needed. When the belt deflector **5b** is not height-adjustable, it can be connected to energy  
25 absorbers which absorb energy and dampen vibration when the first shoulder belt portion moves it up.

30 e) In another embodiment the upper belt deflector **5a** (**Fig. 13**) can be rigidly attached to the head rest **3.6a**. Any adjustment of the height of the head rest **3.6a** to the head automatically adjusts the height of the upper belt deflector to the shoulder. This feature differs from the D-ring ref. to DE 40 10 452 A1, which is in contact with the shoulder belt, when the passenger is thrown forward, and is moved up to intercept the head, when thrown backward.

- f) In resting position the shoulder latch plate 2, in plug-in connection with an assisting buckle assembly 16, 16a, 16b fastened to the seat cushion 3.1, B-, C-post section or seat backrest (Figs. 1, 2), is easily accessed by the passenger having the intention to use the belt.
- g) The seat belt can be equipped with a belt-feeding device, manually operated or by a drive apparatus, for example, hydraulic-piston cylinder unit, electrical motor (not drawn), which enhances the convenience and comfort of the user. This drive apparatus is switched on by a pressure sensor, built to the seat, or an existing switch such as lighting-, door- or touching switch. If the belt is not engaged within a dwell time, a control device is activated to switch off the drive apparatus and to reposition the belt-feeding device in resting position.
- h) For the convenience of the passenger, when stepping out, or a quick-rescue of the passenger, when being rescued in accidents, the master release button 84 of the buckle assembly 9.1 is depressed to release all latch plates from the buckle assemblies and/or to return the belt-feeding device to the resting (home) position.
- i) The round rollover tubes 20.2b of the seat backrest frame 3.4d are designed to guide the belt housing 20.4c, 20.4d (Figs. 18, 19), to act as safety bars in a rollover and to allow free view to the rear owing to openings 97R, 97L (Fig. 23).
- j) In another embodiment the seat belt can be connected to the seat in more than three attachment-points (Figs. 1, 14, 23), in which both thighs (femurs) are restrained, thus protecting the passenger from submarining in a front, rear collision or rollover or when in sleeping position. Unlike the suspender- (waist-) belt, consisting of several belts, the portions of multi-point seat belt need not be adjusted in length, when the circumference of the passenger varies depending on the clothes worn.

## BRIEF DESCRIPTION OF THE DRAWINGS

A number of embodiments, other advantages and features of the present invention will be described in the accompanying tables and drawings with reference to the xyz global coordinate system:

**Table 1** shows test data such as left / right thigh-force, belt force and pitch-angle of driver and co-driver in 50% offset crash test of several European vehicles.

**Table 2** shows yaw angle O of driver / co-driver in a 50% offset crash tests.

**Table 3** shows test data of the safest child-restraint system Chico Shuttle® at the converted velocity of 55 km/h in comparison with the safest vehicle among them listed in **Table 1**.

Fig. 1 is a perspective view of a seat with buckle assemblies attached to the seat backrest and seat cushion as well as of the 1st embodiment of restraint system consisting of a multi-point seat belt 1, latch plate 11 along the lap belt, shoulder latch plate 2 of belt end, in the direction of arrow „Z” in plug-in connection with an upper buckle assembly 4, and a seat belt in X-shape, formed by crossing both shoulder belt portions 1.1, 1.2.

Fig. 2 is a perspective view of a seat and of the 2nd embodiment of a restraint system comprising three-point seat belt 1e having a transition latch plate 2, which will be inserted into a transition buckle assembly 4e of a shoulder belt 1.11, pulled in the direction of arrow „Z”.

Fig. 3 illustrates load cases I, II and III in z-y plane in the event of a real-world accident.

Fig. 4 is a perspective view of a restrained dummy thrown forward in VW Polo® in a 50% offset crash test.

Fig. 5 illustrates a yaw-acceleration  $\ddot{O}$  and yaw-angle  $O$  of a vehicle about the vertical axis „z<sub>A</sub>” in a 50% offset crash test of two identical vehicles.

Fig. 6 illustrates a yaw angle  $O$  of vehicle about the vertical axis „z<sub>A</sub>” in a 50% offset crash test into a stiff barrier.

Fig. 7 illustrates four collision types „U1” to „U4” ref. to the research work of Institute of Vehicle Safety, a Dept. of German Insurers Association.

Fig. 8 is a front view of a seat belt ref. to DE-OS 26 02 875 in home position.

Fig. 9 is a front view of a double X-shaped seat belt ref. to DE-OS 26 02 875.

Fig. 10 is a front view of a single X-shaped seat belt ref. to DE-OS 26 02 875.

Fig. 11 is a top view of a  $\angle$ - shaped seat belt ref. to DE 37 41 831 A1.

Fig. 12a is a schematic, perspective view of the 1st embodiment of a buckle assembly 4a, equipped with release cable 4.2.

Fig. 12b is a schematic, perspective view of the 2nd embodiment of a buckle assembly 4b, equipped with an electrical release-motor 4.2b.

Fig. 13 is a perspective view of an upper belt deflector of the head rest.

Fig. 14 is a perspective view of a latch plate 11 of a lap belt portion 1.3 in plug-in connection with a buckle assembly 8 and of the 1st embodiment of a belt-feeding device 20 of the seat belt.

Fig. 15 is a perspective view of the 2nd embodiment of a spatially-adjusting belt-feeding device 20a from the resting position to the operating position and of a height-adjustable belt deflector 5b.

Fig. 16 is a schematic view of the 2nd and 3rd embodiment of spatially-adjusting belt-feeding devices 20a and 20b in kinematics from the operating position to the resting position in x-y plane.

Figs. 17a to 17f are schematic, perspective views of the belt-feeding device 20 in kinematics from the resting position to the operating position.

Fig. 18 is a schematic, perspective view of a seat, equipped with the rollover tubes 20.2b, and of the 4th embodiment of a belt-feeding device 20c.

Fig. 19 is a schematic, perspective view of a seat having the rollover tubes 20.2b, the 5th embodiment of a belt-feeding device 20d, provided with a safety bracket 20.6, a height- and width-adjusting mechanism 27, 27a.

Fig. 20 is a cross-sectional view of the 1st embodiment of the height- and width-adjusting mechanism 27 along the line I-I of Fig. 19.

Fig. 21 is a cross-sectional view of the height- and width-adjusting mechanism 27 along the line II-II of Fig. 20.

Fig. 22 cross-sectional view of the 2nd embodiment of the height- and width-adjusting mechanism 27a along the line I-I of Fig. 19.

Fig. 23 is a front view of the seat 3a to 3d, in which the restraint systems 1a to 1d are integrated, for passengers of different weights and body proportions (sizes).

## DESCRIPTION OF THE PREFERRED EMBODIMENTS OF THE INVENTION

The advantages of the preferred embodiments in the Chap. "INDUSTRIAL APPLICABILITY" are outlined hereinafter with regard to the functions and features thereof.

The method of the present invention capitalizes on the premise that a seat belt is employed to restrain a passenger in at least four attachment points of the seat to distribute all acceleration dependant loads, particularly the yaw  $\ddot{\alpha}$ -acceleration-dependent torque  $T_{\alpha}$ , thereto in an accident, thus ensuring the operation of a single belt retractor to pre-tension (bias) as well as tension the belt, restraining both shoulders, upper- and lower part of the body and lowering all the loads, in particular, in co-operation with the energy-absorption when a number of sets of energy absorbers is put into use. This will be apparent when all forces, imposed on the belted passenger, shown in Figs. 3 and 4, are formulated in the event of a front collision, where the loads of the mass  $D_s$  of the torso are lowered because

- the forward motion „ $w_v$ ” is minimized, thus substantially reducing the pitch-acceleration  $\ddot{U}_H$  and force  $F_{Hy}$  of the mass  $D_H$  of the head, and
- the yaw-acceleration  $\ddot{O}$  is minimized, thus substantially reducing the torque  $T_\delta$ , imposed on the head. Great torque  $T_\delta$  is the most latent force, responsible for sudden death.

5 To a great extent massive head injuries can be avoided.

Load case I in z-y plane: The rotating mass  $D_S$  rotates about the rotating axis „S” at the pitch-angle  $U_S$  and mass  $D_H$  about the rotating axis „z” at the pitch-angle  $U_H$  in Table 1, thereby resulting in the pitch-accelerations  $\ddot{U}_S$ ,  $\ddot{U}_H$  and rotating forces  $F_{Sy}$ ,  $F_{Hy}$ . The addition of both  
10 rotating forces yields the force  $F_V$  linked to the forward motion  $w_v$  of passenger, shown in Fig. 4.

In front- and/or rear collision the passenger is exposed to the submarining force  $S_y$ , shown in Fig. 14.

15 Load case II in x-y plane: The upper part of body is subjected to the torque  $T_\delta$ , exerted by the yaw-acceleration  $\ddot{O}$  about the rotating axis „z”. When the upper part is restrained in an X-shape, the torque is substituted by a pair of forces.

Load case III in x-z plane: The rotating mass  $D_S$  rotates about the rotating axis „S” at the  
20 rotating angle  $U_y$  and mass  $D_H$  about the rotating axis „z” at the rotating angle  $U_{Hy}$ , thereby resulting in the rotating accelerations  $\ddot{U}_y$ ,  $\ddot{U}_{Hy}$  and rotating forces  $D_{Sy}$ ,  $D_{Hy}$  (not drawn). In a rollover the passenger is subjected to the load  $F_{Sz}$ .

Load case IV: In turbulence-related vibrations of an aeroplane the load  $D_{Sy}$  together with  $D_{Hy}$   
25 takes the form of periodical load  $\pm F_{Hx}$ ,  $F_{Sz}$  of  $\pm F_{Sz}$ ,  $T_\delta$  of  $\pm T_\delta$ ,  $S_y$  of  $\pm S_y$  and  $F_{Sy}$  together with  $F_{Hy}$  of  $\pm F_V$ .

The restraint system, illustrated in Fig. 1, is provided with a conventional belt retractor 13 having a clamping device, housed in the B-, C-, D-post section or in one of both sides SL and SR of a seat backrest 3.2 and connected to the belt end EL. The other belt end ER is provided  
30 with a shoulder latch plate 2, which is retained, loosely guided by a lower belt deflector 17, fastened to the vehicle floor, and inserted into one of the buckle assemblies 4, 4a to 4c, 14, 14a, 18, 18a, 18b, arranged in or to the seat backrest 3.2. In all embodiments an additional latch plate 9 can move along the seat belt 1 between both belt ends EL and ER. When plug-in connecting the shoulder latch plate 2 (in the direction of arrow "Z") to the buckle assembly 4



and the latch plate 9 to the buckle assembly 9.1, an X-shaped restraint of the upper part of body and both shoulders as well as a restraint of the lower part of body are accomplished by both belt portions 1.1, 1.2 and the lap belt portion 1.3.

In the 2nd embodiment, shown in Fig. 2, a transition product, comprising conventional three-point seat belt 1e and new parts, has to be invented due to the delay resulting from the production of multi-point seat belts 1. The floor fitting (not shown) is replaced by lower belt deflector 17. The end of the lower shoulder belt portion 1.11 is provided with transition latch plate 2. The end of an upper shoulder belt 1.12 and the other end are equipped with a transition buckle assembly 4e, having release button 84c, and with a second belt retractor 13a, arranged in the seat backrest 3.2. The restraint in an X-shape is defined by plug-in connection of transition latch plate 2 with the transition buckle assembly 4e. In order to resolve the above-mentioned drawback D1, the spring force of the second belt retractor 13a, to retract the shoulder belt 1.12 on depressing the release button 84c, is far less than of the belt retractor 13. Despite the circumference of the restrained passenger, varying depending on the clothes worn, and the different seat position the shoulder belt portion 1.11 always projects through the lower belt deflector 17 at a sufficient length of "l<sub>1</sub>" in order to maintain the function of the belt retractor 13 to retract, to block the belt as well as to release the retracted belt during the travel and the function of the belt tightener (not drawn), incorporated in the belt retractor, to forcefully retract (withdraw) and tighten the belt in an accident. The release button 84c of transition buckle assembly 4e, arranged to or in the seat, can be controlled neither by release cable 4.2 nor by electrical release-motor 4.2b. Hence, the release button 84c can only be activated by signals when depressing the master release button 84.

The other end of shoulder belt 1.12 can be connected either to a coupling fitting 1.2a, 1.2b (Figs. 12a, 12b, 18, 19) or to the belt retractor 13a (belt retractor 13 shown in Fig. 18) having a coupling fitting 1.2b in order to receive a number of energy absorbers to dissipate great impact energy and dampen strong vibration.

In another embodiment the shoulder belt 1.12a consists of the transition buckle assembly 4e and a shoulder latch plate 2a (not shown), similar to latch plate 2, which is plug-in connected to

- the upper buckle assembly 4, 4a to 4c, 14, 14a, 18, 18a, 18b, 18.1 to 18.3, arranged in the seat backrest, in operation position or
- the assisting buckle assembly 16, 16a, 16b in resting position.

When motor vehicles are already licensed, modification of different seats and three-point seat belts can easily be accomplished by arrangement of at least one buckle assembly, of the lower belt deflector 17, of the second belt retractor 13a and by collection of one-piece, detachable shoulder belts 1.12a with different length. Furthermore, the latch plate 2a can be detached  
5 from the buckle assembly by depressing the master release button 84.

A first shoulder belt portion 1.1 is defined by the upper shoulder belt 1.12, 1.12a and the lower shoulder belt portion 1.11.

At an expensive modification or at new transport system the use of belt-feeding device 20, 20a to 20d enhances the convenience and comfort, where the shoulder belt 1.12, 1.12a having  
10 transition buckle assembly 4e is a part thereof.

Evidently, the three-point seat belt 1e in plug-in connection with the shoulder belt 1.12, 1.12a serves as a transition solution for the multi-point seat belt 1, 1a to 1d during the production.

In the above-mentioned embodiments to resolve the above-mentioned drawback D3 the upper part of body is restrained by extending the shoulder belt portions crosswise in an X-  
15 shape

c1) when at least one latch plate 2 is plug-in connected to the buckle assembly of the seat backrest; or

c2) when a latch plate 2, arranged to the end ER of the first shoulder belt portion 1.1 of a belt-feeding device 20a, 20b, is plug-in connected to the buckle assembly of the seat backrest;  
20 or

c3) when the belt-feeding device 20, 20c, 20d positions the first shoulder belt portion 1.1, the belt end ER of which is arranged to or in the side SR of the seat backrest, from the operation position to a resting position.

These features c2) and c3) have the advantage that the common practise to operate the  
25 conventional three-point seat belt is preserved.

In order to resolve the above-mentioned drawbacks D2 and D4 great energy is absorbed and strong vibration is dampened by a large number of energy absorbers connected to the respective buckle assemblies 4, 4a to 4c, 4e, 7, 8, 8a to 8d, 9.1, 14, 14a, 15, 15a, 18, 18a, 18b, 18.1 to 18.3, 19, 19a, 19b, 19.1 to 19.3 (Figs. 1, 14, 19, 23) into which latch plates are  
30 inserted.

As shown in Figs. 1 and 14, the seat belt 1 is equipped with an anti-submarining latch plate 11, which can be connected to one of the buckle assemblies 7, 8, 8a to 8d, arranged in or to the seat frame 3.3. When plug-in connected, the lap belt portion 1.3 is subdivided into two

belt portions 1.3R, 1.3L. Owing to the restraint of both thighs the submarining problem in front- or rear collision, in rollover or turbulence-related vibration of an aeroplane is resolved. Moreover, the passenger, lying in a sleeping position, is well protected.

Because the reel (spool) of the conventional belt retractor can accommodate only a limited length of belt, it is possible that the length of the seat belt for the sleeping position is insufficient. As exemplified in Fig. 1, a buckle assembly 8b, 8c is provided with a release button 84e and a length-adjustable belt, fastened to the seat frame, for the purpose of compensating the length of seat belt 1 between the sleeping and normal position.

A buckle assembly 8d, provided with a release button 84d, is attached to the front portion of the seat cushion.

Owing to the plug-in connection of the anti-submarining latch plate 11, 25 with one of the buckle assemblies a lady in a long gown as well as a child are well protected from submarining (Fig. 23).

The lower belt deflector 17 comprises a housing having an attachment hole to receive a pin 17.1. Both members can be made in one piece. If necessary, the pin 17.1 is surrounded by a sleeve 17.2 of plastics, having corrugation or knobs, which is a common part of the conventional D-ring 12. This D-ring 12 can be replaced by the lower belt deflector 17. The aperture of the belt deflector 17 to loosely guide the belt portion is dimensioned to such a size to retain the latch plate 2 in resting position, thus allowing the use as a three-point seat belt.

In the 1st embodiment ref. to Figs. 14, 17a, 17d the belt-feeding device 20 in resting position is provided with a device to countersink the belt-feeding plate 20.9 in the seat backrest to improve the overall impression of the seat-design, whereon the sales success depends.

When the passenger takes his seat, a drive apparatus, being activated,

- moves up over the head rest the belt-feeding plate 20.9 (Fig. 17a) and then the guide tube 20.1 with the operating arm 20.2, whose belt ring 20.8 houses and loosely guides the first belt portion 1.1 (Fig. 17b);
- rotates the operating arm and the first shoulder belt portion over the head rest, his head and in front of the upper part of his body 95 at „β” (Fig. 14), where in a contact position a key of the operating arm projects through a receptacle of the belt-feeding plate 20.9 or a clamping receptacle 20.11 of the belt-feeding plate 20.9a (Figs. 17c, e, f); and

- countersinks the belt-feeding plate 20.9 or 20.9a and the guide tube 20.1 with the operating arm 20.2 until reaching the operating position in which the first shoulder belt portion extends across over the upper part of his body and the drive apparatus is switched off (Fig. 17d).

5 To prevent the entanglement of the first belt portion 1.1 behind the seat, particularly when positioned furthest forward, that belt portion 1.1 in resting position is intercepted by the belt-catching member 20.7, 20.7a (Figs. 14, 17a, 17b).

When the seat 3c (Fig. 23) has a high seat backrest, the curved guide tube 20.1 of belt-feeding devices 20a (Fig. 15) can be modified in a straight-running operating arm 20.2 of the  
10 belt-feeding device 20.

In the 2nd or 3rd embodiment the belt-feeding device 20a or 20b is provided with a height-adjustable belt housing 20.4a and radial-adjustable tube 20.3 (Figs. 15, 16). Both devices differ from each other by the position of the guide tubes 20.1 on the seat backrest. Each guide tube can be driven by a drive apparatus, housed in the seat backrest. The guide tube 20.1 of  
15 the belt-feeding device 20a is pivotally attached in a stiff supporting tube 3.61 of the height-adjustable head rest 3.6a.

The height of „ $\Delta h$ ” of belt housing 20.4a, having a latch plate 2, plug-in connected to any buckle assembly 4, 14, 18, is adjustable when the passenger moves two openings, facing each other, along the operating arm 20.2a. Alternatively, the passenger can move a handle 5.2, such  
20 as locking handle 27.5 of the height- and width-adjusting mechanism 27, 27a (Figs. 15, 19 to 22), to adjust the height of „ $\Delta h$ ” of upper belt deflector 5b.

The belt-feeding devices 20a, 20b have to meet the following criteria:

- Passengers freely get in and out of the vehicle compartment thanks to the distances of „a” and „b” between the post section 91 and operating arm 20.2a (Fig. 16) in resting position;  
25 and
- the device, when moved, doesn't interfere with the head rest 3.6a, height-adjustable about „ $\Delta h_k$ ”, and with the head of the passenger with/without hat 92.

Regarding the kinematics of the height-adjustable belt housing 20.4a with the latch plate 2 from the operating position to the resting position, the trajectories of „Ba2” and „Bb” are not  
30 in the range of a hat thanks to a radial-adjustable tube 20.3 incorporated into the operating

arm 20.2a. Without the radial-adjustable tube 20.3 the operating arm in the trajectory of „Ba1” interferes with that hat.

In the 4th and 5th embodiment ref. to Figs. 18, 19 the belt-feeding devices 20c, 20d differ from each other by the rotatory movement of the operating arm 20.2, whose guide tube 20.1 is pivotally attached to a bearing casing 20.10. Preferably, upon the rotation about the head, the translatory and rotatory movement of belt are synchronised.

To form the upper part of the seat backrest frame 3.4d a pair of angle fittings 26a, a pair of rollover tubes 20.2b and a pair of side girders 27.1a or four tubes 27.1 (not drawn) are form- and/or force-locking connected to each other by connecting pins 26.2, 26.3 (drawn with dotted lines) and/or by welding, bolting, glueing and/or riveting. The belt housing 20.4c or 20.4d, having a moveable safety bracket 20.6, is guided by rollover tubes 20.2b and driven by an electrical motor 20.5 along the threaded spindle 20.1a, fastened to both angle fittings 26a, from the resting position (drawn with dotted lines) to the operating position, and back again. In the operating position the holes of the rollover tube 20.2b and belt housing 20.4d are aligned with each other, thus permitting the legs of the safety bracket 20.6, loaded in the event of rollover of a convertible, roadster or sport-utility vehicle, to project therethrough and clamp or jam the first shoulder belt portion 1.1.

Upon plug-in connection of the latch plate 2 with the buckle assembly 4, 4a, 4b the belt end ER of belt portion 1.1 is connected to the coupling fitting 1.2a, 1.2b (Figs. 12a, 12b), whereto a number of energy absorbers is attached to absorb energy. In a cost-saving embodiment without the latch plate 2 and buckle assembly, the belt end ER of belt portion 1.1 is directly connected to the coupling fitting 1.2a or 1.2b (Fig. 18) to receive energy absorbers, the retaining elements of which are fastened to the seat backrest frame 3.4d. In order to absorb great energy and damp strong vibration in the event turbulence-related vibrations of an aeroplane or accident of a fast speeding car or high-speed train, the belt retractor 13, coupling fitting 1.2b of which is connected to energy absorbers, is moveable attached to the oblong holes of a stiff plate 13.3, fastened to the seat backrest frame in the side SR so that the other belt end EL can be exploited to receive additional energy absorbers. In excess of threshold value the belt retractor pulls the clamping elements along the respective retaining elements to absorb energy and damp vibration.

In the 1st and 2nd embodiment (Figs. 12, 21) the buckle assembly 4a, 4b, 4c is form- and/or force-locking connected to the seat backrest frame.

For the convenience of the passenger when egressing from the vehicle and in cases of emergency the following embodiments of detachment are proposed:

To disconnect the latch plates 2, 11 and/or 25 from the buckle assemblies 14, 14a, 15, 15a (Fig. 1) and buckle assemblies 18, 18a, 18b, 18.1 to 18.3, 19, 19a, 19b, 19.1 to 19.3 (Fig.

23) of the seat arrangement, particularly for children, as well as from the buckle assemblies 7, 8, 8a to 8d (Figs. 1, 14), the master release button 84, when depressed, activates the release cables 4.2 and/or electrical release-motors 4.2b, which pull the release button 84a and/or 84b of the buckle assemblies (Figs. 12a, 12b, 21).

When depressing the master release button 84 the drive apparatus of the belt-feeding device 20, 20a to 20d returns the first shoulder belt portion 1.1 from the operating position to the resting position.

According to the traffic- or flight law during the travel or turbulence-related flight passengers must remain belted. The need for a belted mother becomes apparent, when she must take care of her frightened children seating on the rear seat. The separately operated release button 84c, 84d, when depressed, detaches only the latch plates 11, 25 of the lap belt portion from the assemblies 7, 8, 8a, 8d (Figs. 1, 23) to annul the protection from submarining.

In the 1st embodiment (Figs. 19 to 21) the height- and width-adjusting mechanism 27 comprises a frame 29, buckle assembly 18.3, 19.3, a pair of tubes 27.4, members 27.5 to 27.9 and a pair of tubes 27.1 having a plurality of locking slots, in form- and force-locking connection with an angle fitting 26a. The frame 29 consists of a pair of outer tubes 27.3, a pair of tubes 27.2 and a connecting member of all tubes. The locking handle 27.5 is form- and force-locking connected to the slots of the inner tubes 27.4.

These inner tubes 27.4, inserted into the outer tubes 27.3, are pre-loaded by the springs 27.6. Each spring 27.6 on a sleeve 27.7, secured by pin 27.8, protruding through the holes of the inner tube 27.4, presses against the spring rest 27.9 of the outer tube 27.3.

The locking handle 27.5 is in engagement with a pair of locking slots of tubes 27.1. The locking handle 27.5, when pulled out from both slots, is detached therefrom. The height of mechanism 27 and buckle assembly can be adjusted

The outer tube 27.3 is provided with a plurality of locking slots q, r, s etc., drawn with dotted lines in Figs. 20, 22.

After the pawl 18.10, pre-loaded by the spring 18.5, is detached from the locking slot r by its movement in the direction of arrow (Fig. 21), the housing 18.12, form-locking connected to the buckle assembly 4c, can be moved along both outer tubes 27.3.

5 Belt-detachable U-shaped latch plates 25 offer the passengers a feature to adapt their body proportions to the appropriate attachment points into which the latch plates 25 are inserted (Figs. 19, 23). Any belt portion, such as 1.1, 1.2, is loosely guided thereby, secured by a quick-release pin 25.1 thereof and detached therefrom by pulling the quick-release pin.

For juxtaposed seats in vehicles, buses, trains and aeroplanes it is recommended to use a single locking handle 27.5 to operate the 2nd embodiment of the height- and width-adjusting  
10 mechanism 27a of each seat 3c having, for example, three pairs of openings 18.1 /19.1 to 18.3 / 19.3 to receive a pair of latch plates (Figs. 22, 23).

The frame 29a consists of two pairs of outer tubes 27.3, two pairs of tubes 27.2, a pair of connecting members of all tubes and members 18.3, 19.3, 27.6 to 27.9a, 27.11, attached to the outer tubes 27.3.

15 The locking handle 27.5 is form- and force-locking connected to slots of the inner tubes 27.4 by the pins 27.12. After inserting these inner tubes into the outer tubes 27.3 the locking plate 27.10 is form- and force-locking connected to the slots of the inner tubes and to the pins 27.12.

After securing the spring rest 27.9a by the retaining rings 27.11, both sleeves 27.7a by the  
20 pins 27.8, protruding through the holes of inner tubes 27.4 and oblong holes of outer tubes 27.3, the inner tubes with locking handle 27.5 are pre-loaded by springs 27.6. The locking handle 27.5, when pulled out from both slots, is detached therefrom. The height of height- and width-adjusting mechanism 27a can be adjusted.

Although the present invention has been described and illustrated in detail, it is clearly  
25 understood that the terminology used is intended to describe rather than limit. Many more objects, embodiments, features and variations of the present invention are possible in light of the above-mentioned teachings. Therefore, within the spirit and scope of the appended claims, the present invention may be practised otherwise than as specifically described and illustrated.